OPERATION AND SERVICE MANUAL

TSC-910

SIGNAL CONDITIONER

RECORDER MANUAL

gulton®

Plotting the Future of Graphic Recording

OPERATION AND SERVICE MANUAL
TSC-910
SIGNAL CONDITIONER

MEASUREMENT & CONTROL SYSTEMS DIVISION
GULTON INDUSTRIAL PARK
EAST GREENWICH, RHODE ISLAND 02818

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WARRANTY

Gulton warrants each instrument to be free from defects in material and workmanship. Our liability under this warranty is limited to servicing or adjusting any instrument returned to the factory for that purpose, and replacing any defective parts thereof (except pens, tubes, fuses, and batteries). This warranty is effective for one year after delivery to the original purchaser, if the instrument is returned, transportation charges prepaid by the original purchaser, and upon our examination, proves to be defective. If the defect has been caused by misuse or abnormal conditions of operation, repairs will be billed at our current rate. In this case, an estimate will be submitted before the work is started. This warranty is in lieu of all other warranties, expressed or implied.

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I. DESCRIPTION OF EQUIPMENT

A. Introduction

The Model TSC-910 Signal Conditioner Module can be used interchangeably with the TR-9800, TR-9400, TR-9600 and TR-9200 model recorders. The TSC-910 accepts AC and DC signals up to 200 volts full scale.

The TSC-910 front panel controls include:

1. Gain Control--The gain control is a potentiometer across the output of the buffer amplifier which controls the amount of signal to the pen motor.
2. Position Control--The position control is a potentiometer across the - and + power supplies. The output from the potentiometer is fed to the pen motor. Stylus position is affected by turning the position control in the desired direction.
3. Attenuator Switch--The attenuator control allows selection of the desired sensitivity and calibration and also isolates the signal conditioner in the OFF position.
4. Vo Adjustment--The Vo adjustment is a screwdriver potentiometer adjustment which compensates for voltage offsets in the TSC-910.

B. Specifications, TSC-910

1. Sensitivity: 10 mv/div., nominal
2. Input Configuration: 500K ohms (± 2%) single-ended, floating.
3. Linearity: ± 1% of full scale (for input voltage up to ± 250 mv)
4. Attenuator Switch:
   a. Position: 9 active from 10 mv/div. to 5 V/div.
   b. Ratio Accuracy: ± ½% typical; ± 1% maximum
   c. Other Positions: OFF, CAL
5. Baseline Drift:
   a. 0.2 div./8 hr. typical; 0.5 div./8 hr. maximum
   b. 0.2 div./10°C typical; 0.5 div./10°C maximum

6. Rise Time:
   a. 4 to 5 msec for 5 mm peak to peak stylus deflection typical. Limited by recorder in which used.
7. Position Adjustment:
   ± 27 Div. (Minimum)
8. Vibration: 3 g's at 2 to 100 hz

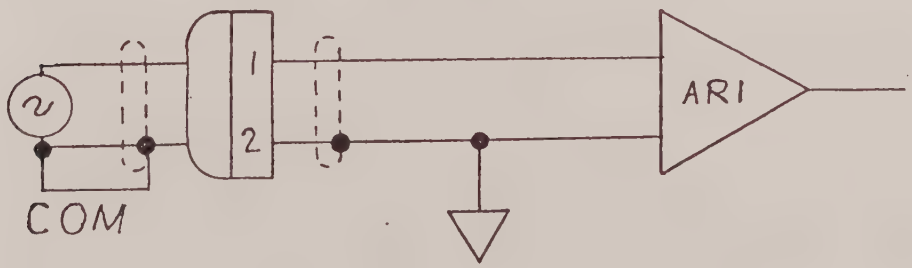
C. Specifications, TSC-910 with Recorder
1. Linearity: ± ¼ div.
2. Hysteresis: 0.1 div. maximum
3. Calibration Voltage: set at 200 mv ± ½ mv
   a. Accuracy: ± 1% for 6 months
   b. Minimum Adjustment: ± 200 mv
4. Power Requirement: 115 V ± 10 V AC 50 Hz or 60 Hz, 6-watts
5. Operating Temperature Range: 0° to 50°C ambient
6. Duty Cycle: Continuous for normal operation
7. Life (MTBF): 10,000 hours minimum for normal operating conditions
8. Io Offset:
   a. 0.1 div. typical
   b. ¼ div. maximum
9. Vo Adjustment: Set to within 0.1 div., (± 3 div. adjustment minimum)
10. Noise:
    a. .1 div. typical
    b. 0.2 div. maximum
11. Maximum Common to Frame Voltage: 125 VRMS 60 Hz

II. INSTALLATION

The TSC-910 Signal Conditioner is designed for ease of installation. Hold the unit upright in one hand and carefully insert the PC board edge of the conditioner into the two slides on the recorder. Push the conditioner fully in until the PC board is inserted into the connector and the module is flush with the front panel of the recorder. The conditioner is then properly in place.

A. Signal Wiring Connections

The TSC-910 is a sensitive signal conditioner in respect to its mv sensitivity and must be wired accordingly. Shielded cable should be used from the input connector to the desired source of signal input. The positive side of the signal should be connected to pin 1. The shield should be connected to the signal common at the signal source to prevent any noise from affecting the signal level. Connect the signal source common to a good earth ground, which will generally reduce 60-cycle noise pickup. The signal cable should be 4 to 6 feet long in order to reduce noise pickup.



SIGNAL INPUT CONNECTIONS

III. OPERATION

A. General Procedure

For all Signal Conditioner calibration procedures, set up Basic Recorder controls as follows:

1. Turn MAIN POWER, ON. Allow 15 minutes warmup.
2. Set CHART SPEEDS selector to 1 or 5 mm/sec. or approximate equivalent.
3. Adjust TRACE WIDTH control for a fine trace.
4. Refer to Specific Procedures below.

B. Specific Procedure, Model TSC-910

1. Turn round locking knobs on GAIN and POSITION controls counterclockwise 1/2 to 2/3 turn to unlock controls, then turn each locking knob clockwise until GAIN and POSITION controls are partially restrained from rotating.
2. Turn GAIN control fully counterclockwise.
3. Using POSITION CONTROL, set trace drawn by Recorder Stylus precisely to the center line of its channel.
4. Turn GAIN control fully clockwise; if the Stylus moves from its center position by more than 2/5 of the smallest chart division, reset it to channel center line by means of the screwdriver adjustment Vo trimmer located behind its front panel access hole, marked "Vo".
5. Set Function Switch to CAL (calibrate) position. Set GAIN control to the position which causes the Stylus to trace a line precisely 20 smallest chart divisions to the right of channel center.
   NOTE: 20 divisions are not equivalent to End Scale deflection, which is 25 divisions.

6. Return Function Switch to the OFF position and verify that the Stylus is tracing a line at exactly channel center; correct if necessary by means of the Position control.
7. Repeat steps 5 and 6 until Stylus traces precisely at channel center in OFF and at +20 chart divisions in the CAL position of the Function Switch.
8. The Signal may now be connected to the Signal Conditioner per Wiring Instructions given in Chaper II. The Position control and Function Switch may now be set at any position within their respective ranges of adjustment.

IV. PRINCIPLES OF OPERATION

The Model TSC-910 Signal Conditioner conditions the input signal and controls the stylus in the particular channel in which it is used in the recorder. The TSC-910 consists of the following circuitry:

A. Signal Input

The module signal input presents a constant 500 K load to the signal throughout the nine available attenuator positions located on position 3 through 11 of the FUNCTION switch. On the circuit board "side" of the attenuator, the initially conditioned signal, referenced against common, passes through protective resistor R16 or R17 to the input clamping zener diodes CR2 and CR3, which effectively limit the maximum signal voltage seen by input pair Q1 to a safe value in case of a severe accidental overload at the input of the attenuator, in which case the excessive signal voltage would be dropped across R16 or R17.

Q1, the input pair, is connected in the now classical Darlington configuration to present a very high (30 to 50 megohms) load to the input attenuator, to keep attenuator loading to a minimum, and to maintain accurate attenuator ratios. Q1 is a single-chip pair, with excellent temperature characteristics. This portion of the circuit, consisting of Q1, R4, R6, R8, and R9 has a voltage gain of unity. The purpose of R9, the front-panel accessible Vo control, is to maintain a zero-input zero-output condition. R4 is a resistor selected to reduce the Io leakage out of the base of the first transistor in Q1 to a level which will cause less than 0.2 divisions of stylus shift when switching the FUNCTION switch through its range, (equivalent to 2 mv at input). The Io is essentially a constant-current flow, and would otherwise produce false "signal" at the input of Q1 equivalent to the Io current multiplied by the resistive value of the attenuator seen by Q1, which varies between 1 K ohm and 500 K ohms as the FUNCTION switch is rotated through its range.

B. Power Supply

The center-tapped secondary of a power transformer feeds a full-wave bridge rectifier module, CR6, whose output gives a positive and a negative voltage with respect to the transformer center tap (P.C. board common). This unfiltered DC output is smoothed by electrolytic capacitors C1 and C2 and then passes to the series regulators VR1 and VR2.

C. Calibration Circuit

The calibration voltage circuit comprises R5, CR1, R1, R2, and R3. Reference zener CR1, a 9-volt unit is connected to the regulated positive voltage supply through R5. This doubly-regulated voltage, available at the junction of R1 and CR5 is fed to a voltage divider string consisting of R1, R3, and trimmer potentiometer R2. The output of R2, derived from its slider, is adjustable over a narrow range around 200 mv, the nominal calibration voltage. This calibration voltage signal is connected to position number 2 of the FUNCTION switch.

V. PREVENTIVE MAINTENANCE

A. Periodic Maintenance - Mechanical Check

These TSC checks are generally recommended every 500 hours of operation or every three to six months, as determined by experience. They may also be used for preliminary troubleshooting. See Section 1 Specifications.

1. Preliminary

Turn OFF all power to the recorder. Remove the signal conditioner by grasping the top and bottom black knobs and then pulling the signal conditioner straight out.

2. Cleaning

Blow out dust and dirt with an air hose. Inspect for foreign particles. Clean the preamplifier panel and knobs with a moist cloth, then wipe dry with a soft, dry cloth. Occasionally rotate each knob through its full scale. This keeps all contacts clean.

3. Inspect for Tightness

Inspect the signal conditioner and power supply for loose transistors, plug-in components, resistors, capacitors, controls, terminal boards, mounting boards, rectifiers, fuses, transformers, etc. Check that all panel-mounted components are securely in place, that all locking controls will lock securely, and that each knob is tight on its shaft.

4. Inspect for Damage

Inspect visually and by smell for burned or worn insulation, leakage, or damaged resistors, capacitors, transformers, etc. Inspect also for corrosion, rust, and electrical or mechanical abuse.

5. Replace

Reinstall the equipment and fasten securely.

D. Stylus Position Control Circuit

The stylus position control potentiometer is connected between the +15 and -15 V busses on the PC board and the slider of this control is connected directly to the position input of the integrated amplifier pen motor.

E. Gain Control Circuit

The gain control potentiometer is connected between the output of Q1 and PC board common. Since the sensitivity of the integrated amplifier pen motor is equal to approximately 8 millivolts per chart division, and since Q1 has a gain of one (1), the rated sensitivity of the system (10 millivolts per chart division) is attained when the slider is stationed at approximately 75% of its full scale (270^{o}) rotation. The control slider is connected directly to the signal input lead of the pen motor servo amplifier.

F. Calibration Adjustment

a. Equipment
   1) Digital Voltmeter $\pm$0.1%
   2) Narrow screwdriver
   3) Extender card TAC-321

b. Procedure
   1) Plug TSC-910 into the extender card and insert the assembly into the recorder.
   2) Push MAIN POWER ON and allow 15 minutes warm-up time.
   3) Connect the plug (+) lead of the DVM to TP7 and the negative lead to COMMON.
   4) Adjust R2 until the DVM is reading 200 ($\pm$1) mv.

VI. TROUBLESHOOTING (TSC-910)

SYMPTOMS	CHECK (DWG. 403864)
No Position, No Output	1. Channel fuse 2. Board connection 3. Power supply a. The output of CR6 is approximately ± 35 VDC; and if not, check CR6, C1 and C2. b. TP8 to COMMON should be +15 VDC; it not, check C1, C3 and VR1. c. TP9 to COMMON should be -15 VDC; if not, check C2, C4 and VR2. 4. If problem still persists, check amplifier circuitry for shorts on the TSC-910 and on the recorder.
Position but no Output	1. TP6 to TP3, if no signal, check connections and CR2 and CR3. 2. TP5 to COMMON, if no output, check Q1 and associated circuitry. 3. TP2 to COMMON, if no signal, check GAIN potentiometer.
Output but no Position	R111 for open
Noise on left side	1. TP9 to COMMON with oscilloscope for AC ripple; if ripple exceeds specifications, check C2 and VR2. 2. Input clamps CR2 and CR3.
Noise on Right side	1. TP8 to TP10 with oscilloscope for AC ripple; if ripple exceeds specifications, check C1 and VR1. 2. Input clamps CR2 and CR3.
Unable to adjust CAL	CR1, R1, R2, and R3.

VII. PARTS LIST

Parts lists are compiled by assembly or subassembly. They are listed first by reference designation in alphanumeric order and then alphabetically by nomenclature. To the right of each nomenclature or part name is the manufacturer (Gulton or otherwise), manufacturer's part number, and then GULTON part number which every part has. Manufacturer's part name and number are given in the PARTS LIST when available. However, it is sometimes more expedient and less expensive to obtain the part locally. Sometimes a part (such as a resistor, where its value is known) may even be available in the customer's own stock of supplies.

MODEL TSC-910

PARTS LIST
DWG. 403866
DWG. 403864

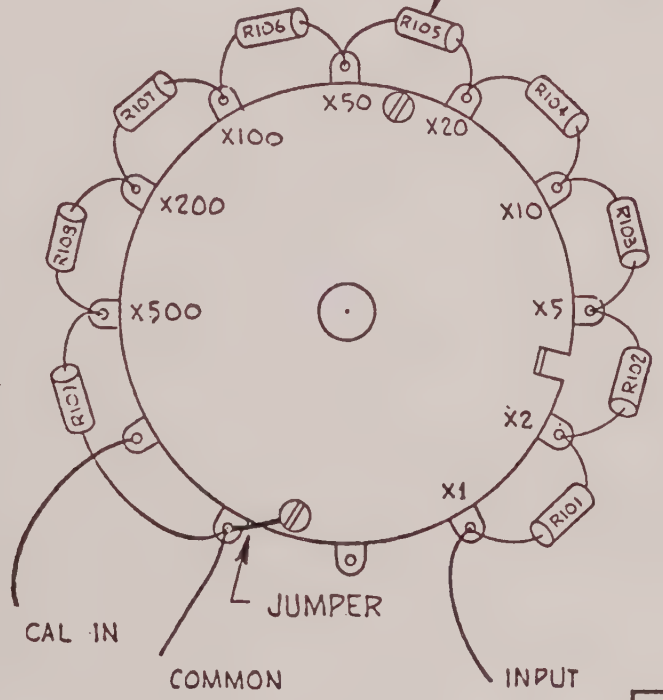
FIND NO.	REF. DESG.	QUAN. REQ.	GULTON PART NUMBER	PART NAME/DESCRIPTION
1	R1	1	100549-5112	RESISTOR, 1/4 W MF 1% 51.1K
2	R3	1	100549-1001	" " " " 1K
3	R5	1	100549-698R	" " " " 698Ω
4	R6	1	100549-4992	" " " " 49.9K
5	R8	1	100549-1004	" " " " 1 MEG.
6	R16	1	100549-1003	" " " " 100 K
7	R17	1	100549-2493	" " " " 249 K
8	R2	1	103954-501	POTENTIOMETER 500Ω
9	R9	1	103954-203	" 20 K
10	R4 *	1	101880-X	RESISTOR, CARBON F
11	R12-R15	4	100556-512	RESISTOR 1/4W, CC. 5% 5.1 K
12	C3, C4	2	107128-106	CAPACITOR, 10µ, TANT
13	C1, 2	2	110565-16	CAPACITOR, 1000µ 40V
14	CR1	1	104154	DIODE, ZENER 9V
15				
16	CR2, 3	2	2-101971	DIODE, SIG. 1N457
17	Q1	1	104468	TRANSISTOR, DUAL TD601
18				
19		2	109757-1	SPACER
20	PD1	1	104305	PAD, TRANSISTOR
21	HS1, 2	2	104613-1	HEAT SINK
22		1	403865	P.C. BOARD
23		1	403864	SCHEMATIC
24	CR6.	1	106080-2	RECTIFIER, BRIDGE
25	VR1	1	110016	REGULATOR 78M15UC
26	VR2	1	110017	" 79M15UC
27				

* 3.R4 TO BE SELECTED BY TEST TO REDUCE EXCESSIVE Io SHIFT.

VIII. SCHEMATICS AND ILLUSTRATIONS

ZONE	SYM	DESCRIPTION	DATE	APPROVED
	H	REDRAWN	9-3-69	
		DELETED R110 & R111 -2 ONLY	2-12-73	
	J	DELETED FIND 11 SCHEMATIC	6/4/73	

NOTE
RESISTORS ARE BETWEEN TERMINALS NOT OUTSIDE. SEE NOTE 1



NOTE:
1. KEEP DIA. OF ASSY AS SMALL AS POSSIBLE.
2. SET LOCKING WASHER FOR (11) POSITIONS.
3. DRESS ALL RESISTER LEAD WIRES TO MAINTAIN A MINIMUM OF 1/16" CLEARENCE BETWEEN LEADS OF ADJACENT RESISTORS IN EACH LAYER

200751-1 200751-2

FIND	DESCRIPTION	PART NO.	QTY	
15				
14				
13	JUMPER		X	—
12	SELECTOR POSITION	TT-7 #2		
11				
10	RESISTOR (1K R109	100549-1001	1	1
9	" (1.5K R108)	" -1501	1	1
8	" (2.49K R107)	" -2491	1	1
7	" (4.99K R106)	" -4991	1	1
6	" (15K R105)	" -1502	1	1
5	" (24.9K R104)	" -2492	1	1
4	" (49.9K R103)	" -4932	1	1
3	" (150K R102)	" -503	1	1
2	" (249K R101)	" -2493	1	—
1	SWITCH ROTARY	1-103541	1	1

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES:
TOLERANCES ON:
FRACTIONS ± 1/64 | DECIMALS ±.005 | ANGLES ± 1°

DRAWN BY: C.W. HALL 30 SEP 69
CHECKED BY: H.H. MAGNESS 10CT69

REMOVE ALL BURRS AND SHARP EDGES. DIMENSIONS AND TOLERANCES SHALL BE HELD AFTER PLATING.

MATERIAL:

CONTRACTOR APPROVAL:
DESIGN APPROVAL:
DOCUMENTATION APPROVAL:

NEXT ASSEMBLY	USED ON
401124	TSC-810
	TR722

APPLICATION:

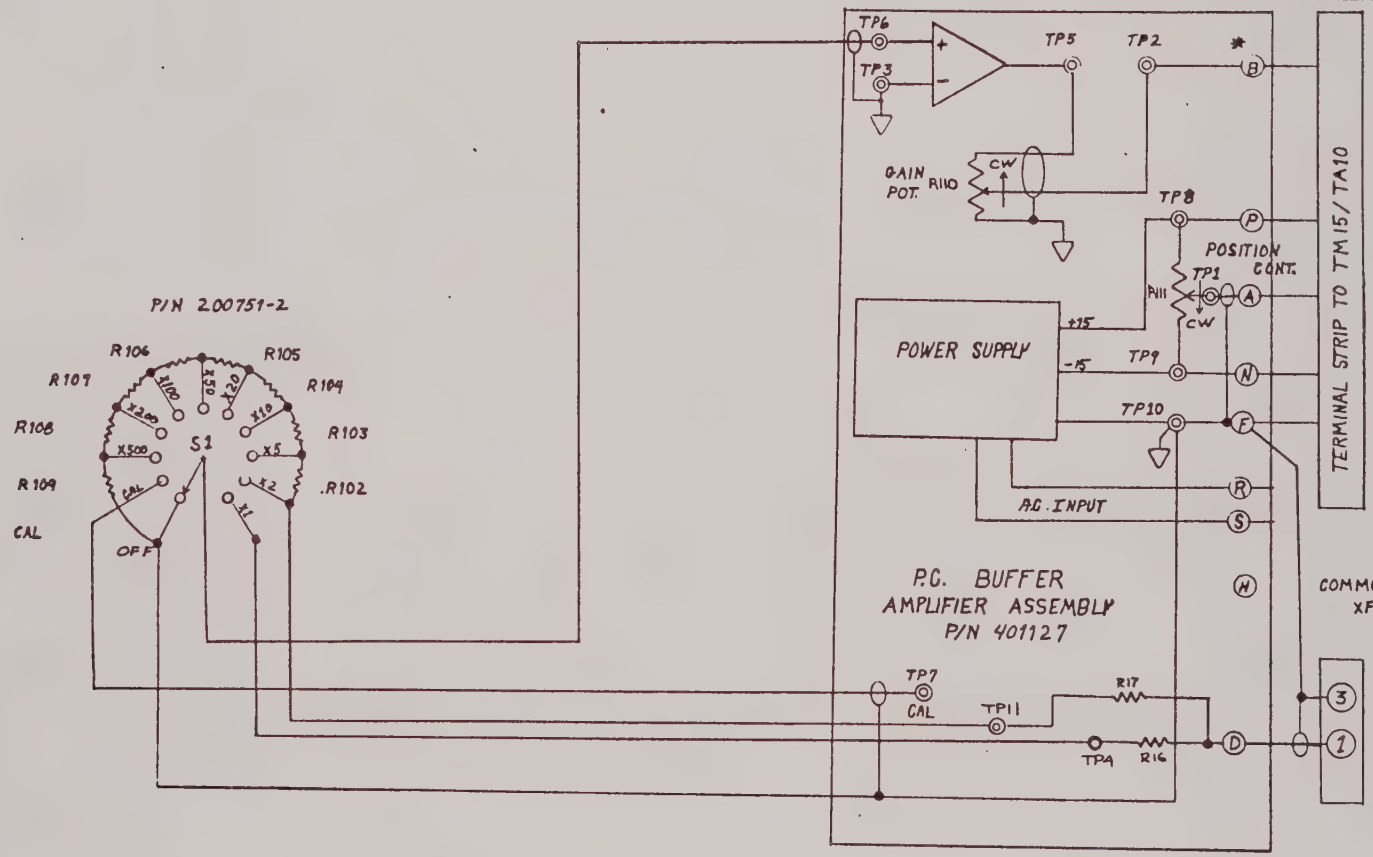
ASSY. - ATTENUATOR

SIZE	CODE IDENT NO.	DWG. NO.
B		200751-X

SCALE: 1:1 | CONTRACT NO. | SHEET 1 OF 1

SIONS

ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	REDRAWN	4/8/69	
	B	ADDED R110 & R111 DESIGNATIONS P.A.L.	5/1/70	20171
	C	DELETED R101; ADDED WIRE X2 to TP11 ECR	2-17-72	30340
	D	PER DCR.	1-15-74	31846



* CORRESPONDING TO P.C. CONNECTOR PIN

BUFFER AMPLIFIER MODULE SCHEMATIC

DWG SIZE	CODE IDENT	SPECIFICATIONS		QUAN REQ	FIND NO.	PART NO. OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION

PARTS LIST

C	401134	TSC 810	
DW	EXT A	U	
SI		ATION	

UNLESS OTHERWISE SPECIFIED

DIMENSIONS ARE IN INCHES:
TOLERANCES ON:
FRACTIONS ± 1/64 | TWO PLACE DECIMALS ± .010
ANGLES ± 1° | THREE PLACE DECIMALS ± .005

REMOVE ALL BURRS AND SHARP EDGES. DIMENSIONS AND TOLERANCES SHALL BE HELD AFTER PLATING. 63 MACHINE SURFACES TO BE √ RMS.

MATERIAL

DRAWN BY: W. GARIEPY DATE 11/18/69

CHECKED BY: T. Yip

CONTRACTOR CERTIFICATION:

DESIGN APPROVAL:

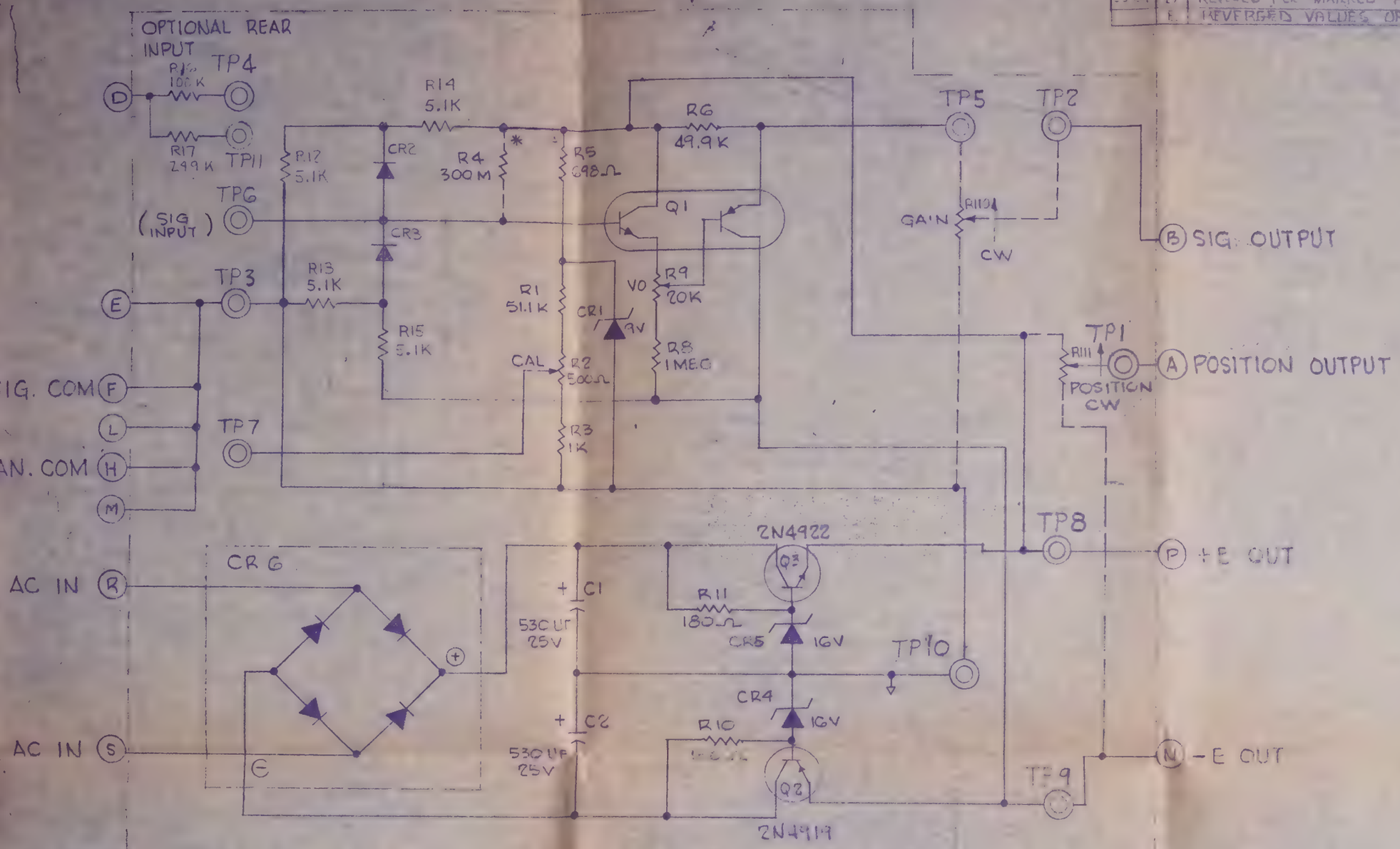
DOCUMENTATION APPROV... SCALE ... CONTRAC...

SCHEMATIC, BUFFER AMPLIFIER MODULE TSC810

SIZE	CODE IDENT	DWG NO.
C		401132

SHE... 1 OF

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	REDRAWN	9 31-69	
	B	CHANGED CR5 TO CR4 & CR4 TO CR5	25 FEB 70	20442
	C	ADDED R111 & R110 DESIGNATIONS	1 MAY 70	[illegible]
6364	D	REVISED PER MARKED PRINTS	2 [illegible]	[illegible]
	E	REVERSED VALUES OF R16 & R17	14 [illegible]	[illegible]



* SELECTED AT TEST WHEN NECESSARY

IO SHIFT	R4 (CARBON FILM OR COMPOSITION
2 TO 4 mv	600 MEG. OHM
4 TO 6 mv	300 MEG. OHM
6 TO 8 mv	250 MEG. OHM
8 TO 10 mv	200 MEG. OHM
10 TO 12 mv	180 MEG. OHM

DWG SIZE	CODE IDENT	SPECIFICATIONS		QUAN REQ	FIND NO.	PART NO. OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION
						PARTS LIST	

L.B. FEB 22

C	AC 134	TS [illegible]
DWG SIZE	NEXT ASSY	USED ON
	APPLICATION	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON:
FRACTIONS ± 1/64 | TWO PLACE DECIMALS ± .010
ANGLES ± 1° | THREE PLACE DECIMALS ± .005
REMOVE ALL BURRS AND SHARP EDGES. DIMENSIONS AND TOLERANCES SHALL BE HELD AFTER PLATING. 63 MACHINE SURFACES TO BE √ RMS.
MATERIAL

DRAWN BY: N.WATSON DATE 9-31-69
CHECKED BY: J.F. CAYEN 10CT69
CONTRACTOR CERTIFICATION:
DESIGN APPROVAL:
DOCUMENTATION APPROVAL:

Gulton techni-rite® INCORPORATED ELECTRONICS

SCHEMATIC, INPUT CIRCUIT

SIZE	CODE IDENT	DWG NO.
C	20	401130

SCALE	CONTRACT NO.	SHEET
—		1 OF

AP 176

P/N 200751

OPTIONAL REAR INPUT

R106 499K · R105 15K · R107 249K · R104 24.9K · R108 2.49K · R103 49.9K x5 · R102 150K x10 · R109 1M x50 · 1500Ω

TP11 · R17 240K · TP4 · R16 100K

R14 5.1K · RG 49.9K · TP5 · TP2

R12 5.1K · CR2 · R4 300M * · R5 698Ω · Q1

TP6 · TP10 · BIG INPUT · CR3 · TP3

GAIN · R110 · CW · B SIG. OUTPUT

R13 5.1K · R1 51.1K · VO · R9 20K · CR1 9V · R8 1MEG

E · COM. · F · R15 5.1K · CAL · R2 500Ω · TP1 · R111 · A POSITION OUTPUT

L · TRANS. COM. · H · R3 1K · POSITION CW

M · TP7

78M15UC · VR1 · TP8 · +15V

P · AC IN · R · CR6 · C3 10UF

+ C1 1000 UF 40 V · + C2 1000UF 40V · C4 10UF

AC IN · S · TP9

N · VR2 · -15V

79M15UC

* SELECTED AT TEST WHEN NECESSARY

IO SHIFT	R4 (CARBON FILM OR COMPOSITION
2 TO 4 mv	600 MEG. OHM
4 TO 6 mv	300 MEG OHM
6 TO 8 mv	250 MEG OHM
8 TO 10 mv	200 MEG OHM
10 TO 12 mv	180 MEG. OHM

DWG SIZE	NEXT ASSY	USED ON APPLICATION
C	403866	TSC-910

DWG SIZE	CODE IDENT	SPECIFICATIONS		QUAN REQ	FIND NO.	PART NO. OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION

PARTS LIST

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON:
FRACTIONS ± 1/64 · TWO PLACE DECIMALS ± .010
ANGLES ± 1° · THREE PLACE DECIMALS ± .005
REMOVE ALL BURRS AND SHARP EDGES. DIMENSIONS AND TOLERANCES SHALL BE HELD AFTER PLATING. 63 MACHINE SURFACES TO BE √ RMS.
MATERIAL

DRAWN BY: PALA · DATE 3-19-78
CHECKED BY: [illegible] 3-22-78
CONTRACTOR CERTIFICATION:
DESIGN APPROVAL:
DOCUMENTATION APPROVAL:

Gulton techni-rite® ELECTRONICS INCORPORATED

SCHEMATIC, INPUT CIRCUIT
TSC 910

SIZE C · CODE IDENT 70 · DWG NO. 403864
SCALE — · CONTRACT NO. · SHEET 1 OF 1

ECR FEB 22 [illegible]

4 3 2 1 · C B A

Measurement & Control System Division
Gulton Industries, Inc., East Greenwich, Rhode Island 02818
401-884-6800 • TWX 710-387-1500

www.manualsplus.com

1030880

For Recorder Manual:

RM-4001